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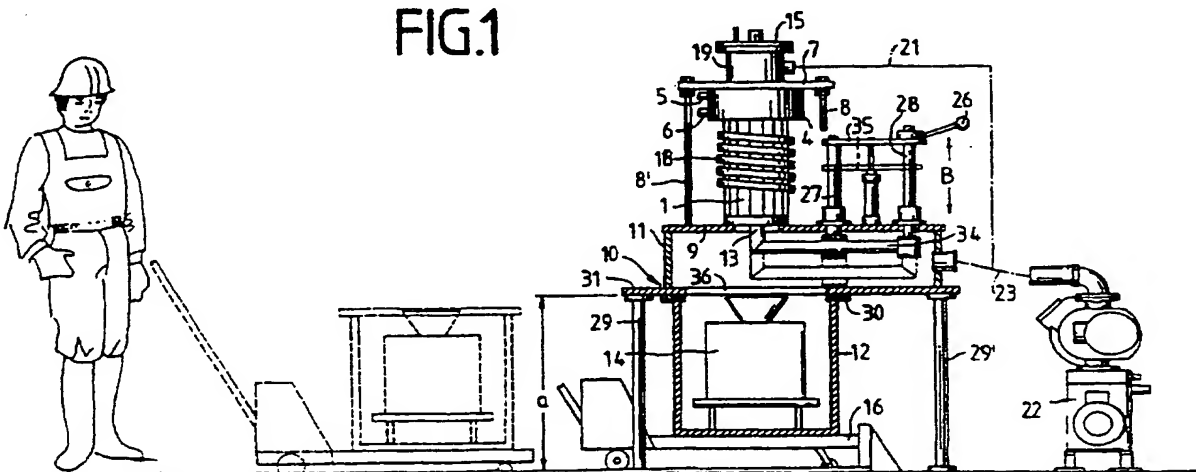
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(54) Abstract Title

Induction heated vacuum crucibles

(57) In a sealed evacuable crucible (1) for inductive melting of metals or other electrically conductive materials, consisting of a plurality of palisades (2, 2', ...) which are arranged parallel to one another, enclose the melt and form the crucible wall, and having a crucible base part (3) which carries the palisades (2, 2', ...), and having an induction coil (18) which is wound around the palisades (2, 2', ...) from outside in direct manner distanced therefrom, and through which there flows an alternating current and which is movable in a vertical direction relative to the crucible (1), and having in the crucible base part (3) a discharge opening (25) which is closable by means of a stopper rod (13), there is provided below the crucible base part (3) an evacuable chamber (10) which is formed of two parts (11, 12,) for receiving a vessel (14) for collecting the molten charge, which is placed below the discharge opening (25), wherein the lower chamber part (12) rests on the transporting surface of a lift-truck (16) and is movable therefrom towards the upper chamber part (11).

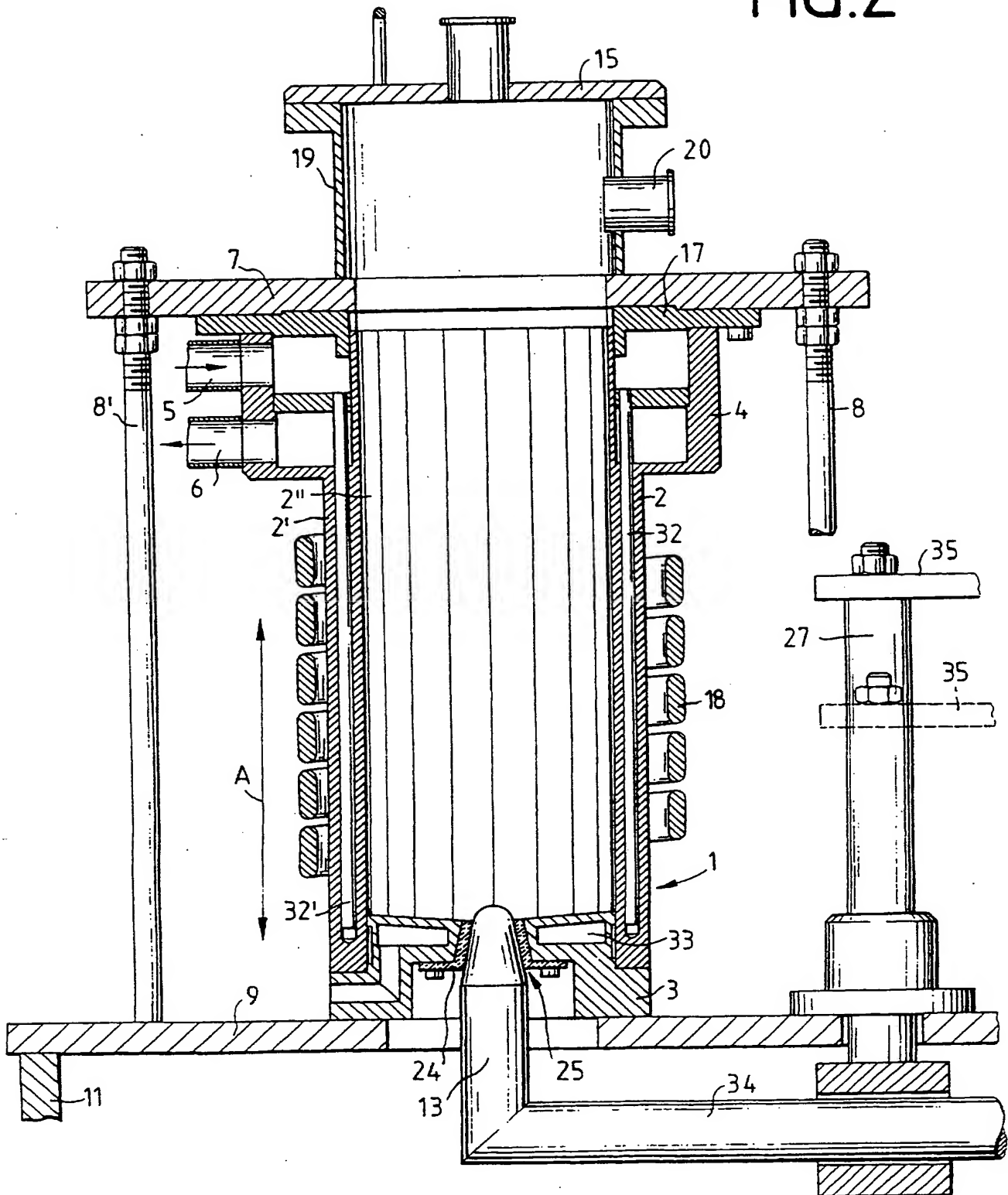
FIG.1



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FIG.2



Sealed evacuable crucible for inductive melting or
overheating of metals, alloys or other electrically
conductive materials

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The invention relates to a sealed evacuable crucible for inductive melting or overheating of metals, alloys or other electrically conductive materials, having a plurality of palisades which are arranged vertically and parallel to one another and distributed on an arc of a circle and distanced from one another, enclose the melt and form the crucible wall, and having a base part which forms the base of the crucible and carries the palisades, wherein the palisades are provided at least in part with voids through which there flows a cooling medium, and having an induction coil which is wound round the palisades from outside in direct manner distanced therefrom, and through which there flows an alternating current.

There is known a process for melting difficultly meltable metals, in particular tantalum, tungsten, thorium or alloys thereof, in a water-cooled vessel (DE 518 499), wherein the vessel is made of substances having a melting point lower than that of the charge material, for example of quartz glass, copper or silver, and the energy necessary for melting is supplied and the vessel cooled such that the charge material is melted-down in residue-free manner without impurities arising from the crucible material. The actual crucible is heatable with the aid of an induction coil, wherein a circulating crucible current is prevented by the composition thereof from individual segments which are separated from one another by an isolating layer, for example of mica.

There is also known a high-frequency induction crucible formed of a plurality of palisades which are all arranged in vertical manner on a disk-shaped base plate together forming a hollow cylinder (US 3 461 215). Cooling water flows through all the current-conducting and heat-

conducting palisades around which there is wound an induction coil. The base plate of ceramic material is provided with a closure by way of which the melt may be removed. Strips of isolating material are inserted between
5 the palisades.

There is furthermore also known a crucible for slag-free melting of high-purity reactive metals in a vacuum chamber (EP 0 276 544), in which cooling water flows through the palisades around which the induction coil is wound in
10 uniting manner and which are bolted firmly to a disk-shaped base plate, wherein the tubular palisades on the one hand are separated from one another by slots and, on the other, are all connected with one another in electrically
conductive manner by way of the base plate which is formed
15 of metal.

There is also known a liquid-cooled crucible whereof the wall is formed by metal tubes having high electrical and thermal conductivity and which is arranged for melting the charge material in the high-frequency field of an induction
20 coil (DE-OS 1 946 735), wherein the crucible wall consists of tube sections arranged parallel and adjacent to one another whereof some have parts which re-enter the interior of the crucible and form the crucible base, and wherein the distance dimensioned between the tubes is so small that the
25 molten charge material cannot pass through the crucible wall, and wherein the crucible base has an opening which is delimited by the tube end sections which form the crucible base and is so narrow that solid charge material cannot pass through, and that a centring ring surrounds the
30 opening. The actual crucible is encompassed by a quartz tube whereof the lower end is closed by a bottom plate and the upper end by a platform in the region of the crucible opening, wherein there is provided a further chamber wherewith the charge opening of the crucible is closable.
35 Below the opening in the crucible base there is provided a vessel which serves to receive the molten charge.

There is furthermore known an induction melting apparatus for the melting of high-melting reactive metals, which is sealed to the atmosphere, has a connection to connect it to a source of negative pressure or an inert gas source (DE-OS 5 42 28 402), has an unlined melting crucible of metal around which there is wound an induction source, and a casting mould arranged below the melting crucible below an outlet, wherein the melting crucible has a lid which hermetically closes the latter and a downwardly directed jacket-form 10 extension in which the casting mould is arranged in sealing manner to the internal jacket surface of the extension.

There is known, finally, a process for melting refractory metals such as, for example, titanium or zirconium (US 2,825,641), in which the water-cooled crucible is provided 15 on the base part thereof with a discharge opening which is closable with the aid of a cooled stopper rod, for which purpose the stopper rod is positioned in the wall of a chamber arranged below the crucible and is activatable externally by means of a handle.

20 The object of the present invention is to provide a crucible of the type under consideration, which suffices without isolating slag material, in which energy losses are reduced, and non-productive times necessitated by carrying out the melting and casting operation are as short as 25 possible.

This object is achieved according to the invention by an opening in the crucible base part, which is closable by means of a stopper rod, and with an evacuable chamber which is provided below the crucible base part and 30 connected thereto in pressure-proof manner and formed of two parts, for receiving a vessel for catching the molten charge, which is placed below the discharge opening, and with a liner of highly refractory material, which forms the discharge opening in the crucible base part, and an arm for

holding and guiding the stopper rod, which is positioned movably on the upper chamber part.

Further features and details are characterised and described in greater detail in the Claims.

- 5 The invention is amenable to a very wide variety of possible embodiments; one such is illustrated in greater detail purely schematically in the appended drawings, which show:

- 10 Fig. 1 a side view of an apparatus according to the invention, consisting of the crucible having an induction coil and upper closure part having a collar, a lower two-part chamber having arranged in the upper part thereof the stopper rod and arranged in the lower part a vessel to receive the molten charge, a vacuum pump in position, an electrical control box and a transport truck having a liftable stage for the lower part of the two-part chamber, which is supported on the latter stage, and
- 15
- 20 Fig. 2 an enlarged illustration of a section through the water-cooled crucible of the apparatus according to Fig. 1.

The apparatus illustrated in Fig. 1 substantially consists of the consisting of a plurality of palisades 2, 2', ... supported on a crucible base part 3, which together form a hollow cylindrical crucible 1, a crucible head part 4 having the connections 5, 6 for a cooling medium, a head plate 7 which, with the aid of tie bolts 8, 8', draws the palisades 2, 2', ... towards a crucible base plate 9, which forms simultaneously the upper wall part of a second chamber 10 which consists of an upper part 11 and a lower part 12, wherein in the upper part 11 of the chamber 10 there is positioned a stopper rod 13, and the lower pot-shaped part 12 encloses a vessel 14 for receiving the

25

30

molten charge, wherein the lower part 12 is supported on a movable stand 16, and a lid part 15 having a collar 19, which upwardly closes the crucible 1.

5 The palisades 2, 2', ... which stand with their lower ends on the crucible base part 3 and are centred with their upper ends by a ring 17, are enclosed by a distanced induction coil 18 which is held displaceably in the direction of the arrow A (that is to say in a direction longitudinal to the axis of rotation of the crucible) by a
10 device which is not illustrated in greater detail.

The lid part 15 is set upon a collar 19 which is connected in fixed manner to the head plate 7, and closes the charge opening for the batch to be treated. The collar 19 has
15 furthermore a connection piece 20 which is connected by way of a suction line 21 to the vacuum pump 22 which is moreover also connected by way of a second suction line 23 to the two-part chamber 10.

There is inserted into the crucible base part 3 a liner 24 of highly refractory material (preferably of graphite),
20 whereof the central opening 25 forms the discharge for the molten material and is closable by the stopper rod 13. Cooling channels 33 additionally pass through the crucible base part 3.

25 The stopper rod 13 is displaceable in the direction of the arrow B by means of the handpiece 26, being for the latter purpose in operative connection with two guidance rods 27, 28 which are passed through the chamber lid 9.

30 The two-part chamber 10 is held on the base with the aid of supports 29, 29', ..., wherein the distance a between the upper chamber part 11 and the base surface is dimensioned such that the lower chamber part 12 which is placed on the lift-truck 16 can be moved into the position represented by a broken line. There is located between the upper rim part 30 of the lower chamber part 12 and the intermediate flange

31 a seal, not illustrated in greater detail, which ensures that the sealed chamber 10 for the melting process can be pumped out, thus enabling the melt discharged from the opening 25 to flow into the vessel 14 and to be separated or removed from the actual apparatus after the melting operation or after the flooding of the chamber 10 and after lowering of the platform of the lift-truck 16.

The modular construction of the apparatus is fundamental to the invention: the slotted, cold crucible 1 is arranged as a self-contained unit on the chamber lid 9 in fixed manner by means of tie bolts 8, 8', ..., wherein the chamber lid 9 forms the upper wall of a chamber 11 which is open downwardly and stands in fixed manner on the base surface with legs or supports 29, 29', There is provided as a third section of the apparatus the lift-truck 16 on the platform whereof the lower chamber part 12 having the vessel 14 arranged therein is placeable, wherein the lift-truck 16 together with the lower chamber part 12 is movable to below the upper chamber part 11 and can be raised so far as to create a pressure-proof connection between the two halves 11, 12 of the chamber 10.

List of reference numbers

	1	crucible
	2, 2', ...	palisade
5	3	crucible base part
	4	crucible head part
	5	connection
	6	connection
	7	head plate
10	8, 8', ...	tie bolts
	9	chamber lid
	10	two-part chamber
	11	upper chamber part
	12	lower chamber part
15	13	stopper rod
	14	vessel
	15	lid part
	16	movable stand, lift-truck
	17	centring ring
20	18	induction coil
	19	collar
	20	connection piece
	21	suction line
	22	vacuum pump
25	23	suction line
	24	liner
	25	discharge opening
	26	handpiece
	27	guidance rod
30	28	guidance rod
	29, 29', ...	support
	30	upper rim part
	31	intermediate flange
	32, 32', ...	void
35	33	cooling channel
	34	connecting rod
	35	bridge
	36	aperture

Claims

1. Sealed evacuable crucible (1) for inductive melting or overheating of metals, alloys or other electrically conductive materials, having a plurality of palisades (2, 2', ...) which are arranged vertically and parallel to one another and distributed on an arc of a circle and distanced from one another, enclose the melt and form the crucible wall, and having a disk-shaped crucible base part (3) which carries the palisades (2, 2', ...), wherein the palisades (2, 2', ...) are provided at least in part with voids (32, 32', ...) through which there flows a cooling medium, and having an induction coil (18) which is wound around the palisades from outside (2, 2', ...) in direct manner distanced therefrom, and through which there flows an alternating current and which is movable in a vertical direction relative to the crucible (1), and having in the crucible base part (3) a discharge opening which is closable by means of a stopper rod (13), and having, provided below the crucible base part (3) and connected in pressure-proof manner therewith, an evacuable chamber (10) which is formed of two parts (11, 12,) for receiving a vessel (14) for collecting the molten charge, which is placed below the discharge opening (25), and having an arm for holding and guiding the stopper rod (13), which is positioned movably on the upper chamber part (11).
2. Apparatus according to Claim 1, characterised in that there is inserted in the crucible base part (3) a liner (24) of highly refractory material, whereof the longitudinal bore forms the discharge opening (25).

3. Apparatus according to Claim 1, characterised in that the stopper rod (13) which extends in vertical manner is coupled with a connecting rod (34) which extends at approximately a right angle thereto, which is guided through the eye of a first guidance rod (27) which is displaceable vertically in the chamber lid (9), wherein the free end of the connecting rod (34) is in operative connection with a second guidance rod (28) which is parallel to the first and is positioned displaceably in the chamber lid (9) and is movable by way of a handpiece (26), wherein the two guidance rods (27, 28) which are parallel to one another are coupled to one another by way of a bridge (35).
4. Apparatus according to Claim 1, characterised in that the upper part (11) of the two-part chamber (10) is provided with supports (29, 29', ...) which hold the upper part (11) at a predetermined distance from the base surface, wherein the underside of the upper chamber part (11) is provided with an intermediate flange (31) which has an aperture (36) and which corresponds with the upper opening of the pot-form lower chamber part (12), wherein the rim part (30) of the aperture (36) forms a sealing surface.
5. Apparatus according to Claim 1, characterised in that the lower chamber part (12) rests on the transporting surface of a lift-truck (16), wherein the distance between the base surface and the intermediate flange (31) of the upper chamber part (11) is dimensioned slightly larger than the distance between the base surface and the continuous upper edge of the lower chamber part (12) when the transporting surface of the lift-truck (16) is lowered.
6. Crucible substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.



Application No: GB 9825129.1
Claims searched: All

Examiner: Paul Gavin
Date of search: 4 February 1999

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:
UK Cl (Ed.Q): F4B(BA,BE,BFJ,BFX,BGJ,BGL,BGN,BGX,BMA,BMJ,BMX,BNB)
Int Cl (Ed.6): F27B(14/04,06,08,10),F27D(3/14, 15/02),C22B(9/00)
Other:

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
Y	GB 2 313 902 A (ALD) - whole document	1
Y	GB 1 427 220 (INRESA) - whole document	1
Y	GB 1 186 806 (STC LTD.) - whole document	1
Y	GB 0 866 928 (HERAEUS) - whole document	1
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